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a	x	v_1 (ft./sec.)	u_1 (mi./hr.)	t_1 (secs.)	(t_2-t_1) (secs.)	t_2 (secs.)	s_1 (ft.)	s_2-s_1 (ft.)
1	9.6825	93.75	63.92	93.754	19.365	113.12	4,394.9	605.1
2	11.278	127.2	86.72	63.595	22.555	86.15	4,044.5	955.5
3	12.264	150.4	102.55	50.13	24.53	74.66	3,770.3	1,229.7
100	18.735	351.0	239.32	3.51	37.47	40.98	616.0	4,384.0
∞	19.573	383.15	261.24	0	39.149	39.15	0	5,000

355 (Mechanics). Proposed by HORACE OLSON, Chicago, Ill.

A solid spheroid, axes a, a, b, is placed with its axis of revolution vertical. From its highest point a particle is projected horizontally with a speed s. Where will it leave the spheroid, assuming that it slides on the surface without friction?

Solution by William Hoover, Columbus, Ohio.

The entire motion is in a vertical central section of the spheroid and all of such sections are equal ellipses.

Let $a^2y^2 + b^2x^2 = a^2b^2$ (1) be the equation of any one of them.

Resolving tangentially,

$$v\frac{dv}{ds} = g\frac{dy}{ds}. \tag{2}$$

Multiplying by ds and integrating,

$$v^2 = 2gy + C. \tag{3}$$

When $v = v_0$, $y = b$, and $C = v_0^2 - 2gb$, and (3) becomes

$$v^2 = v_0^2 - 2g(b - y). \tag{4}$$

If ρ = the radius of curvature, we have, at the point where the particle leaves the curve

$$\frac{v^2}{\rho} = -g\frac{dx}{ds}. \tag{5}$$

Now from (1),

$$\rho = \{(a^2 - b^2)y^2 + b^4\}^{3/2} \div ab^4 \tag{6}$$

and

$$\frac{dx}{ds} = -ay \div \{(a^2 - b^2)y^2 + b^4\}^{1/2}. \tag{7}$$

Substituting (6) and (7) in (5) and reducing,

$$(a^2 - b^2)gy^3 + 3b^4gy + b^4(v_0^2 - 2gb) = 0, \tag{8}$$

a cubic for y. Now put $a = a/2$, $b = b/2$, $v_0 = s$.

In (8), if $b = a$, and $v_0 = 0$, $y = \frac{2}{3}a$, as is well known for a circle of radius a.

Also solved by Paul Capron.

QUESTIONS AND DISCUSSIONS.

Send all communications to U. G. Mitchell, University of Kansas, Lawrence.

NEW QUESTION.

35. Is the theorem given below new or has it previously been published?

Theorem. *If two parallel planes, π and π', cut sections from a cylindrical surface S and two spherical surfaces S_1 and S_2, and if the sum of the sections of S_2 is equal in area to the sum of the sections of S and S_1, then the part of S_2 included* *between π and π' is equal in volume to the sum of the parts of S and S_1 included between π and π'.*

Note. In communicating the above question Mr. Elbert O. Brower, of Cicero, Illinois, says (in substance): "The truth of this proposition so easily follows from a consideration of the ordinary formula for getting the volume of a spherical segment, that it is difficult to suppose that it is unknown; yet I am led to wonder how it happens that, if known, it has not been accorded the prominence which it would seem to deserve. In sending it to the MONTHLY I wish to determine whether or not it is original with myself."—U. G. M.

DISCUSSIONS.

I. RELATING TO THE TRANSITION CURVE.

By GEORGE PAASWELL, Civil Engineer, New York City.

The transition curve is a so-called railroad spiral used to ease the approach to a circular curve. It is defined by its intrinsic equation $d\varphi/ds = 2ks$, where s is the distance along the curve measured from the point of zero curvature and k is a constant determined by the special data of the circular curve for which the transition is an easement. The integration of this equation gives $\varphi = ks^2$. Taking the length of the transition as L and the radius of the circular curve as R, the value of k is found from the intrinsic equation to be $1/2RL$.

From the geometry of the infinitesimal triangle $dy = ds \sin\varphi$ and $dx = ds \cos\varphi$, or, substituting from the above the values of ds and s, we have

$$dy = \frac{1}{2\sqrt{k}}\,\frac{\sin\varphi}{\sqrt{\varphi}}\,d\varphi; \quad dx = \frac{1}{2\sqrt{k}}\,\frac{\cos\varphi}{\sqrt{\varphi}}\,d\varphi; \quad y = \frac{1}{2\sqrt{k}}\int_0^{\phi}\frac{\sin\varphi}{\sqrt{\varphi}}\,d\varphi\,;$$

$$x = \frac{1}{2\sqrt{k}}\int_0^{\phi}\frac{\cos\varphi}{\sqrt{\varphi}}\,d\varphi.$$

Expanding the integrals, integrating term by term and replacing k by its value $\sqrt{\varphi}/s$, we get

$$y = s\sum_0^{\infty}\frac{(-1)^n\varphi^{2n+1}}{(4n+3)\lfloor\underline{2n+1}}; \qquad x = s\sum_0^{\infty}\frac{(-1)^n\varphi^{2n}}{(4n+1)\lfloor\underline{2n}}.$$

Defining two functions,

$$\text{tran}\,\varphi = s\sum_0^{\infty}\frac{(-1)^n\varphi^{2n+1}}{(4n+3)\lfloor\underline{2n+1}} \quad\text{and cotran}\,\varphi = s\sum_0^{\infty}\frac{(-1)^n\varphi^{2n}}{(4n+1)\lfloor\underline{2n}},$$

we have $y = s\ \text{tran}\,\varphi$, $x = s\ \text{cotran}\,\varphi$, and, maintaining the same analogy, $\text{tatran}\,\varphi = \text{tran}\,\varphi/\text{cotran}\,\varphi$, so that $y = x\ \text{tatran}\,\varphi$. It may be advantageous to make up tables of these functions, similar to the trigonometric tables, and problems in the transition may be expressed in terms of these new functions. At present there is no rigorous mathematical discussion of this curve.